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APPLICATION

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TITLE: WOVEN TOUCH FASTENER PRODUCTS

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WOVEN TOUCH FASTENER PRODUCTS

TECHNICAL FIELD

This invention relates to woven touch fastener products.

BACKGROUND

Some of the earliest versions of touch fastener products were woven. Although such woven products have been displaced in many modern applications by low cost molded hook components and non-woven loop components, woven hook and loop fasteners are still frequently found in applications requiring high strength and cycle life. They are also known to be readily attachable by sewing them directly to underlying portions of a garment or bag.

Although known for their strength and longevity, woven fastener products can be stiffer and thicker than some of molded and non-woven counterparts of lesser fastening strength and/or longevity.

In general, continued improvements in woven touch fasteners are sought, particularly improvements that make such fasteners more appealing for applications where high closure strength and cycle life is required, but where stiffness and thickness are particularly disadvantageous.

SUMMARY

Several aspects of the invention feature a woven touch fastener component in which the fastening elements (whether hooks or loops) are rather thin, either as compared to their height or to the thickness of the ground fabric into which they are woven.

According to one aspect of the invention, a woven loop fastener product includes a fabric base having ground yarns that include interwoven warp yarns and filling yarns extending respectively in warp and filling directions. The pile yarns are interwoven with the fabric base to form engageable loops extending from one side of the fabric base for engagement with hooks. Specifically, the pile yarn filaments extend from a near side of the fabric base to a mean loop height that is less than about 30 times the nominal pile yarn filament diameter.

In some embodiments where a particularly low profile and flexible fastener component is desired, the fabric base has an overall thickness, exclusive of the pile yarns, of less than about 0.010 inch (0.254 mm), for example, 0.0075 inch (0.191 mm).

The fabric base preferably has an overall thickness, exclusive of the pile yarns, of less than about 5 times the nominal pile yarn filament diameter.

For some applications, the loop component has a griege basis weight, with the pile yarns in an unnapped condition, of less than about 300 grams per square meter.

The fabric base preferably has an overall unnapped thickness, as a sum of fabric base thickness and the mean loop height, of less than about 0.15 inch (3.81 mm), for example, 0.10(2.54mm) or 0.070 (1.78 mm). In such an embodiment, mean loop height is preferably less than about 0.10 inch (0.254 mm), for example, 0.06 (0.152 mm).

In some cases, the pile yarns each comprise multiple filaments, the pile yarns each preferably of between about 160 and 300 denier and each pile yarn filament preferably between about 10 and 30 denier, for example, more preferably between about 15 to 25 denier.

The pile yarn filaments preferably have a tenacity of at least 3.5 grams per denier, more preferably at least 4.0 grams per denier.

In some embodiments, the ground yarns are multifilament yarns each having a denier of between about 70 and 140.

The Gurley stiffness of the component is preferably less than about 200 mg.

In some instances, the mean loop height is less than about 27 times the nominal pile yarn filament diameter, preferably about 24 times the nominal pile yarn filament diameter, such that the loop filaments are particularly thick in comparison to the height of the loops.

For some applications, the component includes a binder, such as a material applied as a coating to a side of the component opposite the loops.

According to another aspect of the invention, a woven hook fastener product includes a fabric base having ground yarns comprising interwoven warp yarns and filling yarns extending respectively in warp and filling directions. The hook filaments are interwoven with the fabric base to form hooks extending from one side of the fabric base for engagement with loops. Specifically, the hook filaments extend from a near side of the fabric

base to a mean hook height of less than about 6.0 times the nominal diameter of the hook filaments.

In some implementations, each hook is formed by a severed hook filament loop extending out of the fabric base at two points separated by a span, measured along a line segment between centers of the hook filament at a near surface of the fabric base. Each hook preferably has a stance ratio, defined as a ratio of the span of the hook to an overall height of the hook from the near surface of the fabric base, of at least 50 percent (more preferably, at least 55 percent).

In some cases, each hook is formed by a severed hook filament loop extending out of the fabric base at two points separated in both warp and filling directions.

Preferably, the fabric base has an overall thickness, exclusive of the hook filaments, of less than about 0.010 inch (0.254 mm). In some cases, the fabric base has an overall thickness, exclusive of the hook filaments, that is even less than the nominal hook filament diameter.

The hook component preferably has an overall thickness, as a sum of fabric base thickness and the mean hook height, of less than about 0.075 inch (1.91 mm), more preferably less than about 0.065 inch (1.65 mm), and even more preferably less than about 0.05 inch (1.27 mm).

In some cases the hook filaments are drawn nylon monofilaments. Such monofilaments have been found to be useful for their strength.

The hook filaments are preferably each between about 0.0065 to 0.009 inch (0.165 mm-0.229 mm) in nominal diameter.

The hook filaments preferably have a tenacity of at least 4.0 grams per denier.

In some applications, the ground yarns are multifilament yarns each having a denier of between about 60 and 140.

The hook component preferably has a Gurley stiffness of less than 500 mg, more preferably less than about 200 mg, particularly when the component is to be secured to particularly thin and flexible substrates.

The hook component preferably has a greige basis weight of less than about 300 grams per square meter.

According to yet another aspect of the invention, a woven hook fastener product includes a fabric base having ground yarns that include interwoven warp yarns and filling yarns extending respectively in warp and filling directions. Hook filaments are interwoven with the fabric base and form hooks extending from one side of the fabric base for engagement with loops. Specifically, the fabric base has an overall thickness, exclusive of the hook filaments, that is less than the nominal hook filament diameter.

Various embodiments of this aspect of the invention exhibit features discussed above with respect to the other aspect of the invention relating to woven hook fastener products.

Another aspect of the invention features a woven hook product with a particularly low ratio of overall basis weight to hook filament diameter.

The disclosed invention can provide a high-cycle fastener product with particularly advantageous strength-to-thickness ratios, as well as good flexibility. As a woven product, the disclosed embodiments have good dimensional stability, edge quality and cycle life, particularly as compared to knitted fabrics. However, the aesthetic appearance of the loop material can approach that of a warp knit. The hook elements of the woven hook are particularly strong for their height, and can have a high stance ratio that can help to keep the hooks erect. In some particularly useful configurations, the hooks can be of a filament thicker than the nominal ground thickness, resulting in a product with a high strength for its thickness and stiffness. The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

Fig. 1 is an enlarged side view of a woven loop fastener component, looking in the weft direction.

Fig. 2 is an enlarged side view of the fastener component, looking in the warp direction.

Fig. 3 is an illustration of the weave pattern of the loop component.

Fig. 3A is a profile view of the weave pattern of the loop component.

Fig. 4 is an enlarged side view of a woven hook fastener component, looking in the warp direction.

Fig. 5 is a magnified view of one of the hooks of the hook component.

Fig. 6 is a top view of the hook component, and Fig. 6A is a view taken along line 6A-6A of Fig. 15.

Fig. 7 is a perspective view of the hook component, with the ground of the hook component curved.

Fig. 8 is an illustration of the weave pattern of the hook component.

Fig. 8A is an profile view of the weave pattern for the hook component prior to cutting.

Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION

Referring to Figs. 1-3A, a low profile female touch fastener component 400 is a woven fabric made by interlacing yarns in a first direction, for example, the warp direction with yarns in a second direction, for example the weft direction, the second direction being generally perpendicular to the first direction. The fabric includes a multitude of ground yarns 402 woven with plain weave and interlaced with a pile 404 yarn that forms the loops of the low profile touch fastener component. Interlacing ground yarns 402 and pile yarns 404 in this fashion results in a female fastener component where loops run the length of the fabric in the warp direction and extend across the fabric in the weft direction. Preferably, both the yarns of the pile and the ground are oriented multifilaments. After the fabric is woven, a binder can be sprayed on the back side of the fabric, and then dried or cured to further stabilize the wove product. One example of a binder is a polyacrylic material, applied to have an average dried basis weight of about 37.1 grams of binder per square meter. Another example is a polyurethane binder with an average dried basis weight of about 22.8 grams of binder per square meter.

The ground yarn 402 has a weight of 100 denier in both the warp and weft directions, while the pile yarn 404 has a weight of 280 denier. The ground yarn 402 has a weight range of, for example, from about 70 denier to about 170 denier, while the pile yarn 404 is heavier, with a weight range, for example, from about 160 denier to about 300 denier. The pile yarn

filament denier range is, for example, from about 10 denier to about 30 denier. The diameter 'd' of the each pile yarn filament is about 0.002 inch (0.05 millimeter), preferably between about 0.001 and 0.003 inch (0.025 to 0.075 millimeter). The material of both the pile yarn 402 and the ground yarn 404 is nylon, such as nylon 66.

Referring particularly to Figs. 1 and 3, the ground warp contains 130 yarns/inch (51 yarns/cm). The ground warp range is preferably from about 122 yarns/inch to about 166 yarns/inch (40 to 65 yarns/cm), including selvedge yarns. The ground weft contains 44 yarns/inch (17 yarns/cm). The ground weft range is preferably from about 38 yarns/inch to 51 yarns/inch (15 to 20 yarns/cm). The pile warp contains 31 yarns/inch (12 yarns/cm). The pile warp range is preferably from about 26 yarns/inch to about 36 yarns/inch (10 to14 yarns/cm), creating an active working body (excluding selvedge yarns) of, for example, from about 291 to about 393 loops per square inch (45 to 60.9 loops/cm^2). A ratio of a nominal pile height Hp, measured above the top of the ground, to a nominal ground thickness T_g is, for example, from about 5.0 to about 9.0, measured in unfinished or greige state. The loop material is finished by napping the pile using as is generally known in the art, to detangle the pile and to allow for better engagement. After napping the pile, the ratio of the nominal pile height Hp to a nominal ground thickness T_g is, for example, from about 6.0 to about 9.0.

The low profile female touch fastener component 400 described above has a Gurley Stiffness in the warp direction of about 187 mg, as measured on a 1" X 1" sample of the fastener component by "Standard Test Method for Bending Resistance of Paper and Paperboard (Gurley Type Tester)," ASTM D6125-97. The female touch fastener component has a greige weight of about 220 g/m^2, including selvedges.

Referring to Figs. 4 to 8A, a low profile male touch fastener component 420 is a woven fabric made by interlacing yarns in a first direction, for example, the warp direction with yarns in a second direction, for example the weft direction, the second direction being generally perpendicular to the first direction. The fabric includes a multitude of ground yarns 422 woven with plain weave and interlaced with pile yarns 424 which will form the hooks after cutting, such as with an oscillating cutter as known in the art. Interlacing ground yarns 422 and pile yarns 424 in this fashion results in a male fastener component where hooks run the length of the fabric in the warp direction and extend across the fabric in the weft direction. Preferably, the ground yarn is a multifilament yarn, while the pile yarn is a

monofilament yarn. After the fabric is woven, a backing is typically placed on the fabric to bond the yarns together. The backing is sprayed as a coating as described above.

The ground yarn 422 in the warp direction has a weight of 100 denier, while the ground yarn 422 has a weight in the weft direction of 70 denier. The ground yarn 422 in both the warp and weft directions has a weight range from about 40 denier to about 140 denier. The pile yarn 424 has a diameter d_1 of 0.0085 inch (0.2 mm). The pile yarn diameter d_1 is preferably between about 0.0065 and 0.0090 inch (0.16 to 0.23 mm). Preferably, the material of both the pile yarn 422 and the ground yarn 424 is Nylon, such as Nylon 6-6.

Referring particularly to Fig. 8A, the ground warp contains 190 yarns per inch (75 yarns/cm). The ground warp range is preferably from about 162 yarns per inch to about 219 yarns per inch (64 to 86 yarns/cm), including selvedge yarns. The ground weft contains 45 yarns per inch (18 yarns/cm). The ground weft is preferably between about 38 and 52 yarns per inch (15 to 20 yarns/cm). The pile warp is 38 yarns per inch (15 yarns/cm). The pile warp is preferably between about 32 and 44 yarns per inch (13 to 17 yarns/cm). The working body contains 405 hooks per square inch (63 hooks/cm^2). The working body hook density is preferably from about 344 to 465 hooks per square inch (53 to 72 hooks/cm^2). Referring back to Fig. 13, the ratio of nominal hook height H, measured above the top of the ground, to nominal ground thickness T_{g1} is 4.8, measured in an unfinished or greige state. The range of the ratio of H to T_{g1} is preferably from about 4.1 to about 4.8, measured in an unfinished or greige state. The nominal ground thickness is, in this example, about 0.007 inch (0.18 mm). The male touch fastener component has a Gurley Stiffness in the warp direction of about 511 mg and a greige basis weight of about 180 grams per square meter, including selvedges in a two-inch working width.

Another embodiment is produced as described above, but with a warp ground weight of 70 denier, a weft ground weight of 40 denier and a pile yarn diameter of 0.008 inch (0.203 mm). The ground warp contains about 190 yarns per inch (78 yarns/cm). The ground weft contains about 76 yarns per inch (30 yarns/cm). The pile contains 38 yarns per inch (15 yarns/cm). The pile yarn is interlaced to produce a product having a ratio of H to T_{g1} of 6.1. This embodiment has a Gurley Stiffness in the warp direction of about 145 mg, making it more flexible than the example described above.

Referring to Figs. 6 and 6A, pile yarn 424 penetrates upwardly through the woven ground, forms an apex 426, and then penetrates downwardly through the woven ground further along the warp direction. Penetration of pile yarn 424 upwardly through the woven ground, and then penetration downwardly through the woven ground, creates a pair of legs 430. The distance 'D' along a line between the centers of each leg in the plane of the upper surface of the ground is preferably between about 0.027 inch and 0.035 inch (0.69 to 0.89 mm). The average height H of the hooks is about 0.05 inch (1.27 mm), resulting in a stance ratio D/H of about 0.6. The hooks are spaced apart across the width of the fabric, with a distance between adjacent hooks being about 1.38 to 1.42 millimeters.

Referring to Figs. 6 and 7, legs 430 are not in a straight line in the warp direction, but are offset. This causes built-in stress in the monofilament pile so that when the monofilament loop is cut to form a hook, the distal end of the hook 440 'springs' away from the severed leg below, forming a space 440 through which a loop may pass to engage the hook.

A number of embodiments of the invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. Accordingly, other embodiments are within the scope of the following claims.